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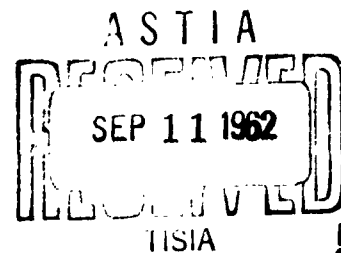
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SPECIAL DUTY REFRIGERATION APPLIANCES

23 August 1962



by:  
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## SPECIAL DUTY REFRIGERATION APPLIANCES

Y-F015-12-501

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### ABSTRACT

A preliminary fact-finding survey of three representative stations in the Pacific area confirms the existence of a real problem in the rapid deterioration of refrigeration appliances.

Ambient conditions at tropical or sub-tropical locations accelerate the decay of equipment so that service lives are substantially decreased. Early replacement and constant maintenance add costs that appear to justify the development of special duty units for use in corrosive environments.

The establishment of design features of cooling and refrigeration appliances especially constructed for use in corrosive areas is recommended.

## INTRODUCTION

Certain advanced bases, especially those located in tropical or sub-tropical climates, have serious corrosion problems. A particularly vexing and costly problem concerns the rapid deterioration of refrigeration appliances. The fact that the continuous operation of these appliances is essential to habitants adds a great deal to the maintenance complexities of the affected stations. A definition of the appliance problem, its probable extent, causes and effects, is the purpose of this report.

## INVESTIGATIVE PROCEDURE

Three Pacific locations were selected for personal investigation with the belief that each of the chosen stations is representative of several others with similar environments. Guam, for instance, has an environment very similar to that of Subic Bay and Samoa; Midway typifies Okinawa and Yokohama, and Kwajalein is representative of equatorial stations. A comprehensive survey of all WesPac stations was not considered essential unless unique problems occurred among the sample stations. DPWO, 14th Naval District and DirPacDivDocks concurred in approving the three selections as a reasonable sampling of the Pacific area. It is recognized that similar problems exist in the Caribbean area but it was not considered necessary to extend the survey to other areas if the sample area appeared to justify specific recommendations.

Since adequate records are not generally maintained on appliances, the material documented in this report was gathered largely by personal observation and from conversations with those Public Works personnel most closely connected with the problem of appliance deterioration over several years. This information is considered implicit since the many qualified informants concur in the findings. A total of twenty-six people were interviewed in the course of the survey.

## Definition of the Problem

The actual types of failures in refrigeration appliances vary widely, from obvious corrosion to mechanical breakdowns. It is generally agreed, however, that 85 to 95% of all types may be attributed, directly or indirectly, to the effects of environment. Mechanical malfunctions are traceable to moisture admitted to the insulation through a corroded case. Electrical relays become inoperable due to excessive moisture and galvanic corrosion causes continuous operation.

Most environmental deterioration is much easier to detect. The most common problem, by far, concerns the corrosion of the exterior

case of freezers, refrigerators and window air conditioners. Exposed units are more rapidly attacked by the atmosphere but a location inside a building does not greatly deter the decaying action. Cases will evidence the onset of corrosion in six months or less, regardless of location.

In order to offset this condition, all stations rarely allow a unit to remain in service longer than 2-1/2 years before it is removed to the refrigeration shop for rehabilitation. Cases are wire brushed and repainted. Door gaskets and vapor seals are replaced. Insulation is inspected and replaced, if necessary. Mechanical components, controls and relays are checked and overhauled to make the appliance again fully serviceable. The average by-yearly cost of this preventative maintenance program for freezers and refrigerators is from \$50.00 to \$60.00 per unit. This unit cost is applicable to a combined total of approximately 5000 refrigerators and freezers at Guam, 1100 at Kwajalein and 700 at Midway.

The preventative maintenance program is certainly economically justified but serves only to extend the service lives of refrigeration equipment to about 70% of that normally expected of domestic equipment. Guam reports an average service life of six to seven years for refrigerators and freezers. Window air conditioners have a maximum life of four years and water coolers last three to five years. Midway reports similar figures, excepting a longer life for water coolers of six years. Kwajalein however, expects refrigerators, freezers and ice makers to last only four to five years, air conditioners two and one-half years, and water coolers two years. Premature deterioration appears inevitable, in spite of the diligent application of preventative maintenance principles.

Responsible personnel have attempted other means to help alleviate the problem of environmental deterioration. Guam instructs the householder in the reasonable care expected and encourages the timely notification of obvious deterioration. Midway has a similar program in effect. Kwajalein is experimenting with coatings applied to new appliances and has recently been encouraged by a decline in maintenance for appliances located in privately air conditioned quarters. All are enthusiastic in their support of a study to help resolve the corrosion problem.

#### ECONOMIC EVALUATION

The lack of recorded data naturally precludes the presentation of a precise economic study. However, the assumptions used in this quantitative estimate are considered to fall well within reasonable bounds

and, coupled with the results of the survey, offer an adequate basis for a comprehensive determination.

For comparative analysis, the following assumptions are made:

1. The normal service life in the Continental United States for domestic refrigerators and freezers approximates 10 years.
2. The initial cost for present units is \$200.00.
3. Units have no salvage value at the end of useful life.
4. The normal annual maintenance costs for domestic units approximates \$10.00.

Using a straight write-off for simplicity:

$$\text{Annual Cost (A)} = \frac{\text{First Cost (C)} - \text{Salvage Value (S)}}{\text{Service Life (L)}} + \text{Annual Maintenance Cost (M)}$$

or, since Salvage Value (S) is taken as Zero:

$$A = \frac{C}{L} + M$$

For units presently in service at Guam: (reported 7-year life

$$A_1 = \frac{200.00}{7} + 30.00$$

$$A_1 = \$58.60$$

Since the service life of an improved unit for use in the field should be at least 10 years and further, since the upper limit of the R&D goal must be something less than the present figure, assume a \$50.00 annual cost (A) and normal domestic performance

$$50.00 = \frac{C}{10} + 10.00$$

$$C = \$400.00$$

The first cost (C) then, may be as high as \$400.00 for a special duty unit with an effected saving of \$8.60 per unit/year. Applied to the 6800 units at the three sample stations only, the minimum total saving would be more than \$58,000 per year.

It is not unreasonable, however, to anticipate an improvement of 30% from the R&D effort.

$$.70 (58.60) = \frac{C}{10} + 10.00$$

$$41.00 = \frac{C}{10} + 10.00$$

$$C = \$310.00$$

If this could be accomplished, a special duty unit costing \$310.00 would have a service life of 10 years and create an average saving of \$17.60 in annual operating costs. The total direct saving at the same three stations would be nearly \$120,000 per year.

#### FINDINGS AND CONCLUSIONS

The problem of rapid deterioration of refrigeration appliances is well defined for the area surveyed. A reasonable expansion may be made to include other locations with similar tropical or subtropical climates.

Premature failures are predominately due to the effects of the corrosive environment. High ambient temperature and relative humidity are assisted by air salinity at island stations to accelerate the decay of existing equipment.

Preventative maintenance extends the service life of most equipment but does not effect a great fiscal advantage.

#### RECOMMENDATIONS

It is recommended that phase II be implemented as outlined in the Memorandum of Procedure dated 12 December 1961. The development of special duty units seems fully justifiable in view of the savings that may be effected. The number of units involved warrants the implementation of special duty specifications.